Docket # 4322/PCT
IN Wilhelm CLAESSEN
Karl GRAFEN
Hermann Josef SPOLGEN
Menrad LUESSE 088583

JC10 Rec'd PCT/PTO 18 MAR 2002

Verification of Translation

I, Jeffrey J. Waldock, akad.Ü. (university trained translator),

c/o Quick Translation Vienna, Helmholtzgasse 10/4, A-1210 Vienna, Austria

declare as follows:

1. That I am well acquainted with both the English and German languages, and

2. That the attached document represents an accurate translation made by me to the best of my knowledge and belief of the application documents of PCT/DE00/02828 as filed on 18 August 2000 with the EPO.

12 March 2002
.....
(Date)

J. Waldock
.....
(Signature of Translator)

USPS EXPRESS MAIL
EV 059 670 734 US
MARCH 18 2002

10/088583
IC10 Rec'd PCT/PTO 18 MAR 2002

3/prts

Docket # 4322/PCT
INV.: Wilhelm CLAESSEN
Karl GRAFEN
Hermann Josef SPOLGEN
Menrad WESP

A filter press

The invention relates to a filter press for filtering suspensions, consisting of a holder, a support plate fixed thereto, a displaceable pressure plate and a packet of vertical filter plates which are arranged between the support plate and the pressure plate, with each filter chamber situated between two filter plates each comprising at least one filter cloth which is guided in an S-shaped manner around two horizontally oriented reversing bodies and with the reversing bodies being movable vertically and relative to the allocated filter cloth by means of two lifting elements of a lifting apparatus, with said lifting elements being arranged on two opposite longitudinal sides of the filter press and being couplable to carriers of the reversing bodies, with said carriers protruding on the face side.

From DE 195 46 701 A1, a filter press is known which is suitable for fully automatic operation and in which the lifting elements are arranged as lifting beams extending over the entire length of the packet of filter plates. Said lifting beams are not displaceable in the longitudinal direction of the filter press, but can be lifted or lowered vertically to the press frame in order to allow an upward and downward movement of the same as a result of the coupling with the carriers of the reversing bodies which are arranged as pairs of rollers. In the course of the vertical upward movement of the pairs of rollers a displacement of the S-shaped wrap of the filter cloth occurs, so that any adhering filter cake is detached and will fall down as a result of the small radius of curvature in the zone of the rollers.

The disadvantages of said known filter press are that the lifting apparatus needs to be designed very massively due to the simultaneous vertical movement of all pairs of rollers and that with

such a filter press it is merely possible to provide a limited filter output, because the number of filter plates and thus the available filter surface is limited.

A further development of the above-mentioned filter press is known from DE 197 45 289 C1. It concerns a filter press of the kind mentioned above in which the filter plate packet is subdivided into several sections and in which the lifting apparatus is provided with carriages for the carriers which are horizontally displaceable in lifting rails and merely ensure the coupling of the carriers of a section of filter plates with the lifting apparatus. There is accordingly a sectional and sequential detachment of the filter cake from the filter cloths which can be realized with a weaker dimensioned lifting apparatus which can thus be produced in a more cost-effective manner.

Despite the unquestionable improvement, the filter press as disclosed in DE 197 45 289 C1 still shows certain disadvantages. For example, the accessibility to the filter plates is made difficult by the lifting rails which extend over the entire length of the packet of filter plates. Moreover, the masses of the parts moved during the discharge of the cake, which although reduced in comparison with the filter press according to DE 195 46 701 A1, are still rather large, so that the complexity and the costs for the lifting apparatus are in total still high.

The invention is based on the object of providing a filter press with sectional and sequential detachment of the filter cake from the filter cloths of the same in which a favorable lateral accessibility to the individual is given as required and, moreover, the complexity of the lifting apparatus for the reversing bodies is reduced.

Based on a filter press of the kind mentioned above, this object is achieved in accordance with the invention in such a way that the lifting apparatus extends in total in the direction of a

longitudinal axis of the filter press merely over a partial zone of the length of the filter plate packet and is movable in the direction of the longitudinal axis of the filter press, with the lifting elements being movable relative to the lifting apparatus merely in the vertical direction.

Whereas the lifting apparatus in the filter presses according to DE 195 46 701 A1 and DE 197 45 289 C1 is fixed to the holder, the lifting apparatus according to the invention is movable in the longitudinal direction relative to the same. The lifting apparatus in its entirety is thus brought into a position in a temporally successive manner in which the reversing bodies are just vertically movable by coupling with the lifting elements which belong to the filter chambers which are currently to be emptied. The lifting rails can therefore (as seen in the longitudinal direction of the filter press) be connected in a rigid manner with the lifting apparatus and are given their mobility in the longitudinal direction of the filter press only via the displaceability of the lifting apparatus in its entirety. Appropriately, the lifting apparatus is held displaceably on the holder of the filter press.

Preferably, in a filter press with 40 filter plates it is possible to empty five sections with eight filter plates each in five successive steps with one lifting process each of a lifting apparatus whose lifting elements can be coupled simultaneously with the carriers of each reversing bodies each.

According to an embodiment of the filter press in accordance with the invention it is provided that the lifting apparatus is a lift-truck which is displaceable on the upper horizontal longitudinal beams of the holder and is provided with two vertically aligned side parts which extend laterally next to the filter plate packet and in which lifting elements are guided. The longitudinal beams, which are present in the press holder in any case, are ideally suitable as a bearing structure for the lift-truck. The lateral guidance of the lifting elements in the vertically aligned side parts

allows the simple use of traction mechanism drives for the vertical movement of the lifting elements, e.g. in form of chain or cable drives.

A further development of the invention is that the lifting elements are provided with receiving elements whose central distance corresponds to the distance of the carriers of the reversing bodies when two adjacent filter plates are spaced at a distance which is defined by the connecting brackets and is necessary for the cake discharge. The total number of filter plates corresponds to an integral multiple of the number of the receiving elements of the lifting elements.

Appropriately, the carriers are arranged in the reversing bodies as horizontally aligned pins and the receiving elements on the lifting elements as tappets which extend vertically upward from a horizontally aligned basic body of the lifting element.

It is provided for in a further development of the invention that the lift-truck is provided with an unlatching device which is adjustable vertical to the same, whereby a switching force for unlatching the connecting bracket can be exerted by means of the contact surfaces of the unlatching device on the switching surfaces of connecting brackets which are flexibly connected to a filter plate each.

In this way it is possible to unlatch the connecting brackets of merely the section in which the cake discharge is to take place and above which the lift-truck is disposed at such time. Due to the vertical displaceability of the unlatching device relative to the lifting truck, the same can be moved at first above the filter plate packet in such a way that the switching surfaces of the connecting brackets are not touched and the filter plates remain mutually locked.

Appropriately, the contact surfaces are arranged as runners and the unlatching device can be swiveled by means of a fluid cylinder from an idle position in which the contact surface is disposed above the switching surfaces to a switching position in which the connecting brackets are unlatched.

In order to produce a thorough cleaning both of the filter cloth as well as the reversing body after the discharge of the filter cake, it is proposed that at least one spray pipe is flexibly mounted on the lifting element which can be transferred from an idle position in which it is disposed vertically and completely outside of a projection of the filter plates in the longitudinal direction of the filter press to a cleaning position in which it is approximately horizontal. The filter cloth can then be charged over its entire width with a pressurized cleaning liquid emerging from the nozzle of the spray pipe under pressure. The vertical upward and downward movement of the spray pipe thus ensures that the entire surface of the filter cloth can be cleaned.

This allows positioning the spray pipe during the detachment process of the filter cake outside of the intermediate space which exists between the filter plates and to swivel the spray pipe into the intermediate space only during the fluid-supported cleaning process. In the position when swiveled in the spray pipe can easily assume a position which would not be possible during the filter cake discharge due to the falling parts of the filter cake.

Appropriately, the number of the filter cloths which can be cleaned during a lifting movement is smaller than the number of the receiving elements present in a lifting element.

Since the volume flow of the cleaning fluid which is required for the thorough cleaning of the filter cloths is relatively high, the totally required volume flow can be limited when only a few filter cloths are cleaned simultaneously. The pump output which needs to be provided can

therefore be reduced considerably as compared with a simultaneous cleaning of all filter cloths of a section, which has a cost-reducing effect.

The overall length of an individual spray pipe can be reduced in such a way that at opposite longitudinal sides of the filter press one spray pipe is disposed which is each assigned to the same intermediate space and the spray pipes are aligned in their cleaning position coaxially with respect to one another with their longitudinal axes. Due to the approximately halved spray pipe length, the stability is substantially increased at the same pipe diameter and the overall height of the filter press can be reduced due to the vertical position of the shorter spray pipes in the idle position.

It is further proposed within the scope of the invention that a transport apparatus is attached to the lifting apparatus for displacing one or several filter plates when the lifting apparatus is stationary in the longitudinal direction of the filter press.

Whereas based on a position in which all filter plates rest against one another the first section is to be opened with the help of the hydraulic closing mechanism of the filter press, this is no longer the case when the filter plates of the second section are pulled apart, since simultaneously with this it is necessary to push together again the filter plates of the previously emptied first section. In summary, the press holder is only dimensioned in its length in such a way that the filter plates of a single section can be pulled apart to the emptying distance.

Preferably, the transport apparatus for the cake discharge is attached to the unlatching device of the lift-truck because this leads to the advantage of smaller required actuating paths and ranges as compared with a transport apparatus which is rigidly attached to the holder. The connection of the transport device with unlatching device offers the possibility in this connection to make the

coupling of a transmission part of the transport apparatus with carriers on the filter plate dependent on the lower position of the unlatching device, i.e. on the unlatched state of the filter plates.

In order to prevent the escape of possibly swelling filter cake from the first filter chamber of the as yet unopened section, it is further provided that the lift-truck is provided with a latching device with which the filter plate which is adjacent to the section of filter plates to be emptied and cleaned can be fastened relative to the lift-truck. The lift-truck is fastened relative to the press holder during the emptying and cleaning process.

The plate transport in filter cloth cleaning occurs other than in the plate transport for the purpose of cake discharge by grasping the tappet of the first plate of the packet to be cleaned next by a carrier fastened to the pivoted unlatching apparatus in conjunction with the movement of the entire lift-truck. For this purpose, a carrier which is fastened to the unlatching device can be brought into engagement with the tappet of the filter plate.

The differences of the plate transport during the cake discharge and during the filter cloth cleaning are explained by the fact that the plate transport during the cake discharge is performed starting at the pressure plate in the direction of the same. During the filter cloth cleaning, however, the plate transport starts in the last plate section at the support plate side in the direction of the same in order to avoid any idle time, which means in the opposite direction as during the cake discharge.

The invention is now explained in closer detail by reference to an embodiment of a filter press shown in the drawings, wherein:

Fig. 1 shows a side view of a filter press, partly in a sectional view;

Fig. 2 shows a front view in a sectional view along line II-II of the filter press according to fig. 1, and

Figs. 3 to 5 show different phases of the discharge and cleaning process with three different positions of the reversing bodies and spray pipes

The filter press 1 as shown in the figs. 1 and 2 for the filtration of suspensions consists substantially of a holder 2 anchored to the floor, a support plate 3 fastened thereto and a pressure plate 5 which is held in a horizontally displaceable manner on longitudinal beams 4 of the holder 2 and which can be pressed with the help of four fluid cylinders F which are disposed on the face side in the direction towards the support plate 3. A packet of vertically aligned filter plates 6 which are also held in a suspended way on the longitudinal beams 4 is disposed between the pressure plate 5 and the support plate 3. A filter chamber is delimited by two adjacent filter plates 6 in the state when pressed together, which filter chamber can be closed off in a pressure-tight way with the help of projecting membrane enlargements extending along the edge and can be charged with the pressurized suspension to be filtered.

As is shown in the figures 3 to 5, the packet of the filter plates 6 consists of chamber plates 6K and membrane plates 6 M which are arranged alternatingly one after the other. A filter cloth 7K of the chamber plate 6K and a filter cloth 7M of the membrane plate 6M form a seal of a filter chamber in both directions, so that during the passage of the suspension through the pores of the filter cloths 7K and 7M the solids to be filtered out are held back in the filter chamber, whereas the filtrate is guided through the chamber plate 6K and the membrane plate 6M to a filtrate outlet. The filter cloth 7K of a chamber plate 6K is tensioned below the same by a rod-shaped

weight 8 and reversed in the zone of the same from one to the other side in order to thus be useable simultaneously for two adjacent filter chambers. The ends of the filter cloth 7K are fastened to the upper face edges 9 of the chamber plate 6K.

A half each of the filter cloth 7K, which means a filter chamber each, is associated with two reversing bodies 10 in the form of a pair of rollers, around which the filter cloth 7K extends in an S-shaped manner. In the closed state of the filter plate packet there are two pairs of rollers each associated with a chamber plate 6K substantially within the vertical projection of the chamber plate 6K below the same.

After the completion of the filtration, pressing and, optionally, the washing process, the filter cake 11 is substantially situated in the chamber half of the chamber plate 6K and preferably adheres to the filter cloth 7K of the chamber plate 6K. The process for detaching the filter cake 11 from the filter cloth 7K will be explained later.

With respect to figs. 1 and 2, it can be seen that the filter press 1 comprises a lifting apparatus in form of a lift-truck 12 which is displaceable by means of a rack-and-pinion gear combination (not shown) on the longitudinal beams 4 of the frame 2 in the horizontal direction. The drive of the pinion R is performed with the help of electromotor 17'. The lift-truck 12 is U-shaped, with the two free U-legs extending in the vertical direction in the form of side parts 13 next to the longitudinal sides of the filter press 1. A vertical displaceable lifting element 14 each is guided in the side parts 13 which are rigidly connected with the other lift-trucks 12. The lifting elements 14 extend in the longitudinal direction of the filter press 1 merely over the length of eight adjacent filter plates 6 for example.

The vertical upward and downward movement of the lifting elements 14 is performed with the help of two drive chains 15 which are each in engagement with a pinion 16 which is driven by an electromotor 17. The lifting elements 14 per se, each comprise four receiving elements 18 in the form of vertically aligned tappets which are fastened to the beam-like basic body 19 of the lifting elements 14. Horizontally extending receiving surfaces 20 of the receiving elements 18 can be brought into contact with the carriers 21 during the upward movement of the lifting elements 14, which carriers are connected via levers 22 with the pairs of rollers. The lifting elements 14 are further provided with upper stop surfaces 23 which during a downward movement of the lifting elements 14 ensure a secure entrainment in the downward direction of the pairs of rollers. Guide profiles 32 are attached to the chamber plates 6K which ensure a secure vertical guidance of the pairs of rollers.

As is further shown from figures 1 and 2, two spray pipes 24 each are swivelably attached to the basic bodies 19 of the lifting elements 14. The spray pipes 24 can be swiveled from the vertical position as shown in the drawings to the cleaning position in which they are aligned horizontally. A slight gap remains between the free ends of the spray pipes 24. The spray pipes 24 are provided with nozzles from which pressurized cleaning liquid can be applied to the filter cloths of the chamber plates 6K and the membrane plates 6M. Adjacent spray pipes 24 are provided in the longitudinal direction of the filter press 1 with such a distance that in successive intermediate spaces they are swiveled in a centrical manner between two filter plates 6 each.

In the upper zone of the lift-truck 12, the same is provided with a vertically adjustable unlatching device 25. The unlatching device 25 is disposed between the two horizontal longitudinal beams 4 and is displaceable in the vertical direction while maintaining its horizontal alignment with the help of a fluid cylinder 26 fastened to the lift-truck 12. This is carried out via respectively disposed articulated levers.

The unlatching device 25 is provided with runner-like contact surfaces 27 with which in the lowered state of the unlatching device 25 a switching force can be exerted for unlatching connecting brackets which connect adjacent filter plates 6. In this way the filter plate packet can remain latched at first after the actual filtration process. The unlatching of the connecting brackets is performed for merely those filter plates 6 which belong to the section to be emptied at the time.

The unlatching device 25 is further provided with a transport device 28 which consists of a fluid cylinder 29 and a carrier element 30 fastened to the end of its piston rod. The carrier element 30 can be brought into contact with the tappets 31 of the filter plate suspension in the lowered state of the unlatching device 25. In this way, the filter plates of an entire section can be pulled apart to the discharging distance by acting upon a single filter plate 6 as a result of the coupling of the filter plates 6 by means of the connecting brackets.

The functional sequence during a discharge and optional cleaning process is described below:

Based on a position of the filter plate packet which is pressed together into a block, the lift-truck 12 is moved to the end of the plate packet facing the pressure plate 5or is already situated there during the filtration process. An unlatching device 33 which is disposed on the side parts 13 of the lift-truck 12 is used to arrest the first filter plate 6 of the second still closed section on the lift-truck 12 and thus on the holder 2. This prevents that swelling filter cakes will press apart the filter plates 6 of a closed section. After lowering the unlatching device 25, the filter plates 6 of the first now unlocked section are pulled apart to a discharge distance by moving the pressure plates 5 with the fluid cylinder F.

The lifting elements 14 are displaced vertically upwardly with the spray pipes 24 in the vertical idle position, as a result of which the receiving surfaces 20 of the four pins 18 come to rest on the carriers 21 of the pairs of rollers and entrain the same upwardly, as a result of which the filter cake is discharged.

For the purpose of emptying the filter chambers of the next section, the lift-truck 12 is moved at first by the respective amount in the longitudinal direction of the filter press 1. The filter plates of this section are unlatched by lowering the unlatching device 25. The filter plates 6 of the unlatched section are pushed apart by the transport device 28, with the filter plates 6 of the previously emptied section being pushed together again. The above process is repeated section by section until all filter chambers have been emptied.

After ending the discharge process there may under certain circumstances be a subsequent cleaning process of the filter cloths with the help of the spray pipe 24. In order to avoid unnecessary idle time, the cleaning process begins after the last cake discharge from the support plate side and not from the pressure plate side like the discharge process. For this purpose the plate packet is closed at first with the exception of the last two chambers of the last section. The spray pipes 24 are swiveled by 90° into the intermediate spaces for this purpose.

This is followed by a renewed upward and downward movement of the lifting elements 14, through which only two filter chambers each are cleaned simultaneously, because merely two spray pipes 24 are present in order to reduce the volume flow of the cleaning liquid and thus the pump output that needs to be provided for this purpose. The carriers 21 of the other chamber plates 6K are not included in this lifting movement because they are located in the intermediate spaces between the receiving elements 18.

The cleaning of the other filter chambers occurs after the lift-truck 12 has been displaced by the required amount horizontally in the direction of the pressure plate. The unlatching device 25 is then swiveled to the unlatching position. A carrier 34 disposed on the unlatching device 25 grasps the tappet 31 of the first plate of the closed plate packet. In the next step the lift-truck 12 is moved in the direction towards the support plate 3, thus opening the next chambers to be cleaned and simultaneously closing the two previously cleaned chambers. This process is repeated until all filter chambers have been cleaned.